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Case report

Primitive hypoglossal artery: demonstration with digital subtraction-, MR- and CT angiography

M. Oelerich, G. Schuierer

Institute of Clinical Radiology, University of Münster, Albert-Schweitzer-Strasse 33, D-48129 Münster, Germany

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Abstract. The primitive hypoglossal artery (PHA) is a rare persistent carotid–basilar anastomosis. Usually it is found incidentally on angiography, but detection may be of importance for patient management. In the presented case MR- and CT angiography, which to our knowledge have not yet been reported in PHA, provided important additional information.

Key words: Hypoglossal artery, primitive – Carotid–basilar anastomoses – Imaging

Introduction

The primitive hypoglossal artery (PHA) is a rare vascular anomaly. Compared with the most commonly found carotid–basilar anastomosis, the primitive trigeminal artery, PHA is considered to be 8–10 times less frequent. Most cases of PHA are detected incidentally when angiography is performed. Diagnosis of PHA is based on the following criteria initially described by Lie [1] and revised by Brismar [2]:

1. The PHA leaves the internal carotid artery as a large extracranial branch.
2. It passes through the anterior condyloid foramen, the hypoglossal canal.
3. The basilar trunk originates from the PHA.

Case report

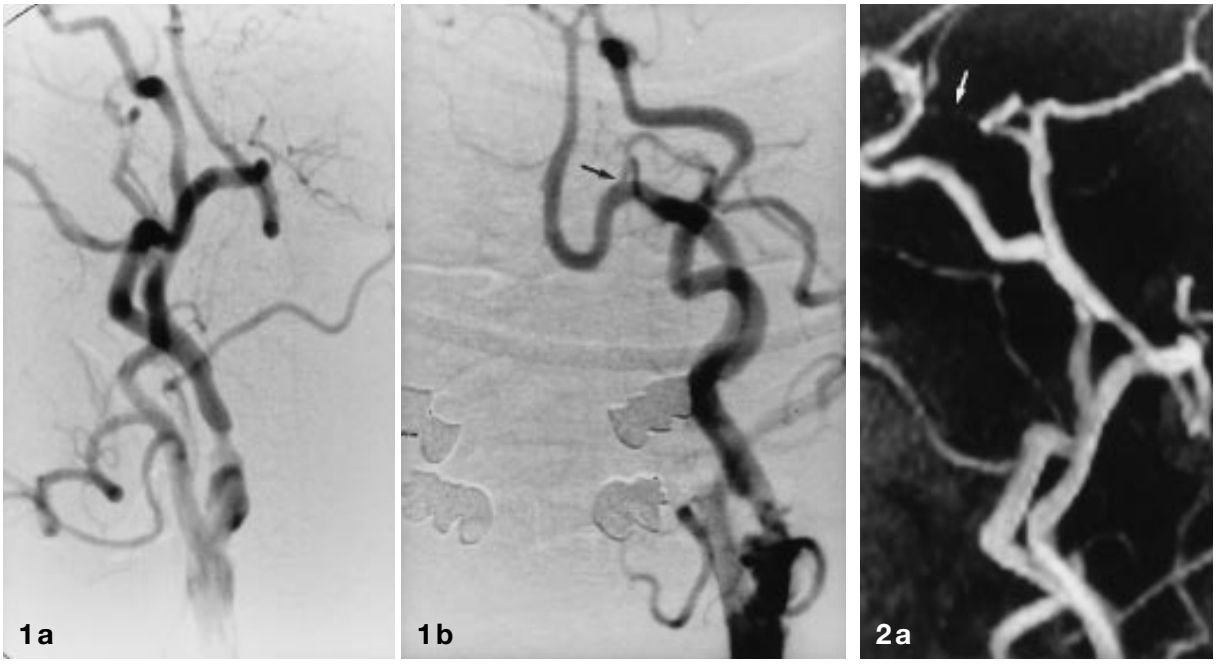
A 56-year-old man who suffered a left occipital and parietal territorial infarction 5 months previously was submitted for intra-arterial digital subtraction angiography (DSA) to further evaluate arteriosclerotic disease. Left common carotid intra-arterial DSA (Fig. 1) revealed a moderate stenosis of the internal carotid artery, which, however, was symptomatic. At the beginning of the second segment a large vessel originating from the internal carotid artery was seen, running posteromedially towards the skull base and finally joining the caudal part of the basilar artery, with a peculiar "hair pin" bend at the anastomosis. The left posterior inferior cerebellar artery (PICA) originated from this carotid–basilar artery. The branches of the basilar artery had a normal course. Semiselective angiograms of the vertebral arteries showed a PICA ending, hypoplastic right vertebral artery and only a filiform vertebral artery on the left side. Based on these findings a PHA was diagnosed. The left internal carotid artery had an elongated extracranial course, which did not allow complete demonstration of the carotid–basilar anastomosis without superposition.

To further analyse vessel anatomy and pathology time-of-flight MR angiography (TOF MRA) was performed at 1.5-T with an MR scanner (Magnetom, Siemens AG, Erlangen, Germany) using a fast imaging with steady precession (FISP) 3D sequence (TR/TE = 38/10 ms, flip angle 20°, 10.25 min aquisition time). Two 80-mm slabs were measured with a slice thickness of 1.25 mm and 64 partitions. The image matrix was 256×256 and the field of view was 200×200 mm. Angiographic projection images were obtained using a maximum-intensity-projection (MIP) program (Fig. 2).

Using this technique the complete carotid–basilar anastomosis, including the left PICA, could be shown without superposition of other vessels. Neither at the origin from the internal carotid artery nor at the anastomosis with the basilar artery was a stenosis or aneurysm of the PHA found. Lateral MIP depicted a hypoplastic posterior communicating artery on the left side, which was confirmed by reviewing the source images.

The patient agreed to participate in a study comparing DSA and CTA in the examination of carotid artery stenosis. Helical CT was performed from the level of the common carotid bifurcation to the skull base after intravenous application of 100 ml contrast media (Ultravist 300, Schering AG, Berlin, Germany) with an injection rate of 2.5 ml/s. Slice thickness and table increment were 1.5 mm and the reconstruction index was

Correspondence to: M. Oelerich



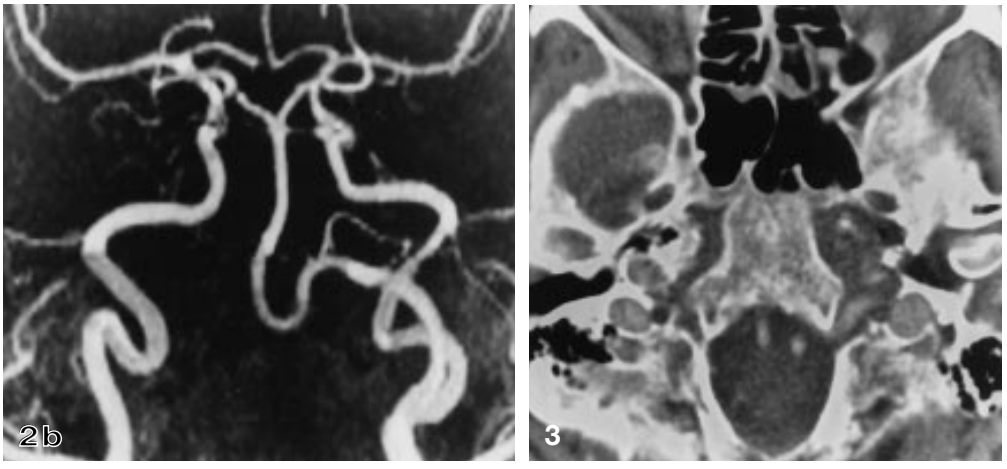


Fig. 1. **a** Lateral and **b** anteroposterior views of intra-arterial digital subtraction angiography show the hypoglossal artery as the major vessel supplying the posterior circulation. Note stenosis of the internal carotid artery and the posterior inferior cerebellar artery origin from the hypoglossal artery *(arrow)*

Fig. 2. Magnetic resonance angiography with **a** lateral and **b** anteroposterior maximum intensity projections delineates the hypoglossal artery comparably to digital subtraction angiography and even shows details such as the posterior inferior cerebellar artery origin and the posterior communicating artery *(arrow)*

Fig. 3. The source image from CT angiography reveals an enlarged anterior condyloid foramen on the left side with the hypoglossal artery passing through it

1 mm. Forty rotations with 175 mA and 100 kV were obtained and the field of view was 160 mm. The source images as well as MIPs were analysed.

The MIP images delineated the extra- and intracranial parts of the carotid–basilar anastomosis and the surrounding structures. On the source images an enlarged left anterior condyloid foramen could be recognized with the carotid–basilar anastomosis running through it (Fig. 3).

Discussion

At the 4-mm stage of the embryo the PHA is one of the four embryological vessels connecting the premordial carotid artery with the longitudinal neural arteries, which later form the basilar artery [1–3]. With development of the posterior communicating arteries and fusion between the vertebral and basilar arteries these temporary collateral vessels lose their function and gradually disappear, beginning with the otic artery, and followed by the hypoglossal, trigeminal and proatlantal arteries. The normal lifespan of the hypoglossal artery is less than 1 week [2].

Usually, as in our case, a PHA is found incidentally during carotid angiography. The reported angiographic frequency is approximately 0.02–0.1 % [4, 5]. However, the detection of this rare vascular abnormality is important regarding the management of the patient as well as pathogenetic considerations. Because of the abnormally large dependent vascular territories, arteriosclerotic disease of the internal carotid artery in patients with carotid–basilar anastomoses sometimes presents with symptoms referring to the anterior and the posterior circula-

tion. This may lead to some confusion in the clinical assessment [5–8]. In the case presented the PHA also was the most likely pathway for cerebral emboli causing a left occipital infarction. Furthermore, cross-clamping of an internal carotid artery during thromboendarterectomy may result in significant decrease of cerebral and brainstem perfusion in these patients [5, 6].

Associated vascular abnormalities can be subdivided into two groups. At first, variations of the posterior vasculature, reflecting the changes in blood supply due to the carotid–basilar anastomosis, are frequently encountered. Initially, the absence of the posterior communicating artery even was considered as one criterion for the diagnosis of PHA [1]. Agnoli [9], in a review of 80 cases of PHA, reported hypoplastic or unopacified posterior communicating arteries on both sides in 78 % and hypoplastic vertebral arteries ipsilateral or bilateral in 79 % of cases. Hence, the anomalies of the posterior circulation in this particular case reflect the rule, rather than the exception. The second group comprises vascular abnormalities, such as arteriovenous malformations and aneurysms, which may cause significant disease. Many reports suggest a higher frequency of these abnormalities in cases with persistent carotid–basilar anastomoses [9–12]. Eadie et al. [4] compared the angiographic findings in 17 patients with carotid–basilar anastomoses with a control group of 100 patients studied consecutively with angiography. They noticed a higher incidence of arteriovenous malformations (11 vs 1 %) in the group with persistent embryological vessels. Patients with carotid–basilar anastomoses were examined twice as often to rule out the source of subarachnoidal haemorrhage. However, both differences were not statistically significant. Other authors have pointed out that usually there is no correlation between the symptoms of the patient and the presence of a carotid–basilar anastomosis [13, 14].

Most cases of PHA are found during routine carotid angiography. Once the abnormal vessel is recognized, it has to be classified according to the previously mentioned criteria, which is possible with DSA in most cases. However, angiography conceals several risks and therefore projections have to be limited to the necessary minimum.

In this regard MRA offers some advantages. Postprocessing of the axial images by the use of MIP techniques provides multiple projections of the vasculature and even unusual axial views eliminating possible superpositions [15]. The MRA technique can be performed without any contrast medium and is a safe and convenient procedure for the patient [16]. Despite the inferior spatial resolution, MRA and DSA were comparable in the demonstration of PHA, and even small vascular structures, such as the left PICA originating from the PHA, were delineated well with both methods. The same is true for other carotid–basilar anastomoses [17].

The carotid-basilar anastomoses usually can be differentiated with routine angiographic techniques. However, sometimes there is confusion about the exact classification. Some pitfalls are pointed out by Anderson and Sondheimer [18]. The most reliable finding to establish the diagnosis of a PHA is the vessel's course through the anterior condyloid foramen, which can be enlarged up to 18 mm [19]. The CTA technique is an excellent tool to prove this anatomical criterion. With increasing use of MRA and CTA in the examination of cerebral vessels, more cases of PHA will be found incidentally with these methods. Therefore, it is important to keep in mind the image characteristics of this rare vascular abnormality.

Detailed demonstration of the vascular anatomy in this case was facilitated by the use of MR and CT angiography which, to our knowledge, have not yet been reported in PHA.

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